MESSAGE TO DELAWARE RADIATION TECHNICIANS

Radiation safety is the business--and the responsibility--of every person taking part in the use of radiation for diagnostic, therapeutic, or research purposes.

There is no doubt that determining the amount of radiation to be applied to a person, and the way it is applied, is the prerogative and responsibility of the licensed practitioner, for instance, a physician or a dentist. However, applying radiation in a way that is safe for the patient, the staff, and the general public is the personal responsibility of each individual involved in the process. To exercise that responsibility, each person who applies ionizing radiation in Delaware must have a basic understanding of how the equipment works, of safety principles and practices, and of the Delaware regulations about ionizing radiation.

To assure that proper safety standards are met, Delaware's Authority on Radiation Protection requires that all Radiation Technologists and technicians be certified as competent in the knowledge and principles of radiation protection. This manual contains the required safety information, together with information on how technicians can become certified, and sample questions of the type that appear in certification examination.

Robin L. Elliott, Chair, 2003
Authority on Radiation Protection
State of Delaware

Frieda Fisher-Tyler, CIH
Office of Radiation Control
DE Division of Public Health

DEFINITIONS

AGENCY	The administrative agent of the Authority on Radiation Protection; i.e., the Office of Radiation Control, Division of Public Health, Delaware Health and Social Services.
AMPERE	The unit of measure of the amount of current flowing in an electric circuit. The unit milliampere (mA) is 1/1000 of an ampere, and is the usual unit used to measure the current supplied to a x-ray tube. The milliampere is used to determine the amount of radiation emitted from the xray tube.
ANODE	The positively-charged side of the x-ray tube. It contains the target.
AUTHORITY	Delaware's Authority on Radiation Protection as specified by 16 Del. Code 7404.
BARRIER **[DRCR F.2(bj)]**	A radiation-absorbing material such as lead, concrete, or plaster, used to protect an individual [DRCR A.2(t)] or an area by reducing exposure.
BITEWING RADIOGRAPHS	Intra-oral films that show the crown portions of opposing teeth in the biting position.
CASSETTES	A holder for x-ray film that protects the film from exposure to visible light but permits penetration of x-rays. Cassettes may be plastic, cardboard or metal.
CATHODE	The negatively-charged side of the x-ray tube. It contains the filament and the focusing device.
CENTRAL RAY	The x-ray that is located in the center of the x-ray beam as it leaves the tube head.
CERTIFICATE	A document issued by the Agency, recognizing the successful completion of an Authority-approved Certification Examination as specified by 16 Del.Code 7406(c). as amended. Unless otherwise specified, a "Certificate" allows practice of Radiation Technology to the level of examination passed. A “Temporary Certificate” may be issued under certain circumstances.
COLLIMATION	The process of restricting the diameter of the x-ray beam which restricts the area of exposure to the patient. Collimation can be by an extension tube or blades that limit the size of exposure to the affected area.

DENSITY	The mass of an object through which the x-ray beam passes, which makes it appear either radiopaque or radiolucent.
DENTAL ASSISTANT	An individual who assists a dentist.
DENTAL HYGIENIST	An individual with formal training in dental hygiene, including application of dental x-rays, licensed by the Delaware Board of Dental Examiners.
DENTAL RADIOGRAPHER	An individual who applies radiation to humans for diagnostic purposes in dentistry. This category includes both Dental Assistants and Dental Hygienists.
DEVELOPER	The solution used in the processing of exposed x-ray film that turns it into a visible image.
ELECTRON	A subatomic particle with a small mass carrying a negative charge. The electrons are converted into xray photons upon striking the target of the anode.
EXPOSURE TIME	The time interval, usually expressed in fraction of a second during which x-rays are generated.
FILM BADGE or DOSIMETER	A recording device worn to record an individual's cumulative exposure to ionizing radiation.
FILM SPEED/ SENSITIVITY	An expression of how much radiation (milliampere-seconds) will be necessary to produce a diagnostic image on the film. Films are produced by the manufacturer with designated speeds by number (i.e., 100 speed, 400 speed, etc.) or letter (ie. D, E, etc.).
FIXER	The chemical solution used in the processing of exposed x-ray film that preserves the developed image by removing the unexposed silver halide crystals. The proper “fixing” of a film allows for extended archival quality.
FOCAL-FILM DISTANCE (FFD) or SOURCE IMAGE DISTANCE (SID)	The distance from the focal spot (target) at the anode of the x-ray tube to the film. It is usually expressed in inches, for example 8-inch FFD. More recently called the source image distance or SID.
FULL MOUTH SURVEY	A series of intra-oral radiographs that gives diagnostic information for all teeth and desired bony areas. It is usually composed of peri-apical and bite-wing films.

IMAGE	Any likeness of an object reproduced on photographic film or other viewing device. The image is the entire radiograph.
ION	An electrically charged (+ or -) particle.
IONIZATION	Process whereby electrically neutral atoms or molecules are converted to positively or negatively charged fragments on exposure to xrays.
IONIZING RADIATION	The kind of radiation that produces ions when interacting with matter. Dental equipment and medical equipment produce this type of radiation.
KILOVOLT (kVp)	One thousand (1000) volts. Used in radiology to describe the kilovoltage setting used to expose a particular body part. The thicker (denser) the part, the higher the kVp setting required to penetrate the part to produce a diagnostic image. kVp determines the quality of the xray beam
LICENSED PRACTITIONER	An individual licensed to practice medicine, dentistry, podiatry, chiropractic, or osteopathy in Delaware. In other words, any individual licensed to prescribe therapeutic or diagnostic radiation for human patients. In addition, this category includes dental hygienists who cannot prescribe radiation.
MILLIAMPERE (mA)	One one-thousandth (1/1000) of an ampere. This unit of measurement predetermines the amount of radiation delivered over a prescribed time (workload). The workload when coupled with kilovoltage determines the quality and quantity of radiation a patient is exposed to and needed to produce the desired diagnostic image.
OBJECT	The structure being radiographed, i.e., mandible, tooth, leg.
OBJECT FILM DISTANCE	The distance between the object (area of patient exposed to xrays) and the x-ray film. Increased OFD, increases magnification of the part and reduces detail.
PANORAMIC RADIOGRAPH	A dental radiograph that shows both the mandible and the maxilla.
PENETRATION	The ability of x-rays to pass through an object and reach the film. Penetration of the beam is determined by the kVp.

PERIAPICAL RADIOGRAPH	An intra-oral film that shows the tooth location and surrounding bony structures.
PRIMARY RADIATION (PRIMARY BEAM)	The original radiation that comes directly from the target of the x-ray tube.
RADIATION	Used for medical and dental imaging. Ionizing radiation can cause cells to mutate and must be used carefully.
RADIATION ABSORBED DOSE	A measurement of the unit of absorbed radiation also known as “Gray”. The older unit is the rad (100 Gray = 1 Rad). In radiation protection, a rad or rem is approximately equal to a roentgen.
RADIATION EXPOSURE	The process of being struck by radiation, either primary or secondary.
RADIATION TECHNICIAN	Section IV, M, of the Radiation Technologist/Technician Certification Regulation – means any individual who has not graduated from a JRCERT -approved or CODA program in radiation technology, but has passed a Delaware-approved examination.
RADIATION TECHNOLOGIST	Any individual who is a Dental Hygienist, a Medical Radiographer, a Nuclear Medicine Technologist, or a Radiation Therapy Technologist who has completed an approved program and is nationally registered.
RADIOGRAPH	The finished visual image of the part produced by exposing an object to radiation and recording that exposure on x-ray film and then chemically processing the film
ROENTGEN	The basic unit for measuring x-ray (ionizing radiation) exposure in air. It is the amount of radiation needed to produce one electrostatic charge in one cubic centimeter of air. The milliroentgen (mR) is 1/1000 of a roentgen (R).
SCATTERED RADIATION	Radiation that changes direction during its passage through matter. It may also be changed in its energy, by attenuation, i.e., become "softer." It is one form of secondary radiation. Scattered radiation can present a serious danger to the operator if appropriate protective measures (time, distance, shielding) are not used.

SECONDARY RADIATION	Radiation that comes from any matter being struck by primary radiation. Secondary x-rays are less penetrating ("softer") than primary x-rays.
SHIELDING	Preventing or hindering the passage of radiation, by use of one or more barriers that attenuate the x-rays. Lead aprons, leaded walls, collimation are all forms of shielding. Patients should have gonadal shielding applied before any radiation that may expose the gonadal region.
TARGET	That part of the anode that the high-speed electrons strike, and that produces x-rays and heat. It is usually made of tungsten.
TECHNIQUE	Term used to define the exposure to the patient based on mA, time, and kVp used to make the radiograph.
TISSUE SENSITIVITY	A measure of the tendency of a given tissue type to mutate when exposed to ionizing radiation. Some tissues (for example, epithelium) are very radiosensitive, while others (for example, bone) are relatively radio-resistant.
TOTAL BODY EXPOSURE	The radiation dosage that describes the effect of an exposure on the entire body of the person.
TUBE	X-ray tube containing the cathode and anode where x-rays are produced.
USEFUL BEAM	The part of the primary radiation that goes where it is aimed and exposes the patient.
WORKLOAD	A measure of the amount of use (high or low) of an x-ray tube in one week and is used to determine appropriate shielding when building a new room. The amount of time that an x-ray tube is used during a week based on the type of exposures performed in a room. Product of x-ray tube “ON” time in a week; milliamperes x seconds, i.e., milliamp seconds per week (mAsec/wk).
X-RAYS	Penetrating electromagnetic radiation. X-rays travel in a straight line from the source and are invisible.

I. CERTIFICATION

A. *The Certificate*

The Delaware Radiation Technologist/Technician Certificate is a permit/license to practice Radiation Technology in Delaware, as required by Delaware Radiation Control Regulations. It is issued to qualified individuals who meet the requirements of the Radiation Technologist/Technician Certification Regulation, by the Office of Radiation Control (ORC) in the Division of Public Health, the Administrative Agent of the Authority on Radiation Protection.

- The certificate is valid only when signed by the Radiation Technologist/Technician to whom it has been issued.
- Under the provision of the Delaware Radiation Technologist/Technician Certification Regulation, “holders of a certificate under these regulations shall display the official certificate or a verified copy in each place of regular employment."
- The certificate is valid for four (4) years from date of issue.
- The certificate is renewable by application to the Office of Radiation Control, accompanied by payment of the prescribed renewal fee.

B. *Who Must be Certified?*

Each Radiation Technologist/Technician in Delaware must be certified in order to practice, according to the "Radiation Technologist/Technician Certification Regulation", as established by Delaware's Authority on Radiation Protection on February 27, 1989. **THIS IS A LEGAL REQUIREMENT**.

Students, who administer radiation under the direct supervision of a Licensed Practitioner or certified Radiation Technologist as part of their training, will not be certified. This applies to a student enrolled in and attending a school or college of medicine, osteopathy, chiropractic, podiatry, dentistry, radiation technology or dental hygiene.

C. *Requirements for Certification*

1. Application

Radiation Technologists**:**

Each Radiation Technologist who is nationally registered or has confirmation for national testing must apply for his/her certificate in writing to:

Office of Radiation Control
Division of Public Health
Department of Health and Social Services
P.O. Box 637
Dover, Delaware 19903

The application must consist of:

- A request that the Certificate be granted by filing official application form ORC-R16 (specify dental or medical).
- Applicant's full name, home address, date of birth, social security number and daytime phone number as required by application form ORC-R16.
- The non-refundable application fee in the form of a check or money order, payable to Division of Public Health.
- A copy of the National Credential or a copy of seat reservation for national registry.

Application and Request to Take the State Exam

Medical Radiation Technician:

- Contact the Office of Radiation Control at the above address for application ORC-R16.
- Complete the application with full name, home address, social security number, date of birth and daytime telephone number.
- Submit the non-refundable application and examination fee by check or money order payable to Division of Public Health
- If accommodations are required by the candidate with respect to the Americans with Disabilities Act, the candidate shall make the need known to the Office of Radiation Control at the time of application.

Dental Assistant Applicants:

- Contact the Office of Radiation Control at the above address to request the Dental Application, the Candidate Information Bulletin and the State Manual.
- Complete and submit the Delaware application payment with check for $10 made payable to Division of Public Health.

- Complete and send the Experior examination application and payment by money order or company check made payable to Experior Assessments, per Experior application guidelines.
- Experior Assessments will forward a test confirmation to each applicant.
- If accommodations are needed by the candidate with respect to Americans with Disabilities Act, the candidate should make the need known when contacting Experior Assessments.
- Certificates will be sent to the home address of the applicant given on form ORC-R16. **Certificate holders are required to notify the State Office of Radiation Protection with any change of name, address or other contact information.**

The application remains valid for a period of (6) months.

A copy of this manual is routinely forwarded to the applicant's address for the first time applicant.

2. Credentialing

Credentialing will be granted if any one of the following criteria is satisfied:

a. The applicant presents evidence of possessing a current credential, registration granted by a recognized national voluntary credentialing body, issued on the basis of an examination satisfactory to the Authority. **Note that the Authority will not accept any certification, registration, or license/permit issued by another state.**

b. The applicant presents evidence of completing an appropriate course of study, approved by the Joint Review Committee on Education in Radiologic Technology/Therapy or the Commission on Dental Accreditation (CODA), or an equivalent course of study acceptable to the Authority and has a seat reservation to take the appropriate national test for certification for which a temporary certification will be granted.

c. The applicant passes the Authority approved state examination.

3. Examination

The Authority has authorized the use of two tests as specified below:

a. The American Registry of Radiologic Technologists Limited Scope State Licensing Examination: This test consists of 1-6 parts: 100 "CORE" questions that every medical radiation technician takes about general radiation safety and patient care. Five other parts are provided for specific body part exams. An examinee may choose from Chest, Ankle and Feet, Skull/Sinuses, Extremities, and/or Spine. This computerized exam is provided by the

American Registry of Radiologic Technologists, through local computer centers, specifically for State licensing requirements. It is non-transferable to other states. Prior to taking any x-rays, the applicant must successfully pass the 100-question core part and at least one other body part exam before a certificate will be issued. Technicians will only be permitted to x-ray body parts based on the tests passed. Bone densitometry applicants need only to pass the core exam.

b. The dental (radiography) assistant examination, prepared by Experior Assessments is intended for dental examinees and it covers aspects of radiation technology and practice pertaining to radiation safety of the dental patient. The Authority intends that passage of this examination will assure that the applicant has sufficient knowledge of radiation principles, with regard both to basic theory and to equipment operation to responsibly and safely administer radiation.

D. Taking the Examination

1. Where?

The tests are provided based on arrangements made with each organization. The Office of Radiation Control will provide information to each applicant on the schedule and sites for testing.

Information may be obtained by calling the Agency at (302) 744-4546, or by accessing the Office of Radiation Control Website at the following:

http://www.deph.org/hsp/orchome.htm

2. When?

The initial examination must be taken within six (6) months of the date of the application.

3. DENTAL APPLICANTS

Stage 1: Applicant contacts the Office of Radiation Control at the above number and submits application ORC-16 and application fee. ORC mails applicant the Delaware State Manual, Experior Exam Application, and Candidate Information Bulletin.

Stage 2: Applicant completes Experior exam application and submits application with appropriate fee directly to Experior.

Stage 3: Applicant may choose to buy the Experior Study Guide by sending appropriate fee to Experior with application.

Stage 4: Applicant selects exam date/location from those listed on the Application.

Stage 5: Applicant takes the examination under the monitoring of the Experior administrator. The Experior administrator is responsible for seeing that the applicant completes the examination within the allotted time without any oral or written assistance.

Stage 6: The administrator returns the test to Experior for scoring.
Stage 7: Experior notifies the State of the examinee's results.
Stage 8: The state notifies the examinee of passing/failing results. Examinees who have passed the examination will receive a certificate. Examinees who are unsuccessful will be provided information on how to reapply to retest.

NOTE: UNTIL EXAMINEE RECEIVES NOTIFICATION OF A PASSING GRADE, THE EXAMINEE SHALL NOT PERFORM ANY RADIOGRAPHIC PROCEDURES.

MEDICAL APPLICANTS

Stage 1. Applicant contacts the Office of Radiation Control at the above number and submits application ORC-16 and application fee. Application and fees received and processed by the Agency.
Stage 2. The Agency mails the Manual to the first time applicant.
Stage 3. Applicant's name added to candidate list for ARRT Examination
. Stage 4. List of candidates sent to ARRT.
Stage 5. ARRT sends candidate's admission ticket for examination to examinee.
Stage 6. Candidate takes test and ARRT grades.
Stage 7. Candidate's score received by State.
Stage 8. The Office of Radiation Control notifies the examinee of pass/fail results. Examinees who have passed the examination will receive a certificate. Examinees who are unsuccessful will be provided information on how to reapply to retest.

NOTE: UNTIL EXAMINEE RECEIVES NOTIFICATION OF A PASSING GRADE, THE EXAMINEE SHALL NOT PERFORM ANY RADIOGRAPHIC PROCEDURES.

A passing score of 75% is required on either examination (also required for each section of the ARRT Limited License Examination).

4. Retesting Privileges

Examinee who fails to pass the examination may be re-examined provided the prescribed application and examination fee is paid each time.

E. PENALTIES

Whoever shall:

1. Sell or fraudulently obtain or furnish any radiation technology diploma, certificate, or renewal, or record of the same, or aid or abet therein; or

2. Practice radiation technology and/or hold or claim to be a registered or certified radiation worker under cover of any diploma, certificate, or record illegally or fraudulently obtained, signed, or issued; or

3. Practice radiation technology without certification under this regulation; or

4. Use, in connection with his/her name any designation tending to imply that the person is a registered or certified radiation worker, without certification under this regulation; or

5. Practice radiation technology when his/her certificate is suspended or revoked; or

6. Violate these regulations in any other manner,

Shall be fined not more than $500, or be imprisoned not more than one year. 16 Del. C. §7416.

II. FUNDAMENTALS OF X-RAYS

Radiation Physics

X-rays are electromagnetic waves, like visible light, microwaves, and radio waves. The difference between these different types of electromagnetic radiation is in their wavelengths, the distance between adjacent peaks of the waves. Our eyes are equipped to see radiation in a certain range of these wavelengths which we call visible light. Radiation at other wavelengths, invisible to the human eye, can only be detected by means of special sensors. Electromagnetic radiation of most wavelengths passes through some materials, for example through air, without either being absorbed or reflected. When visible light passes through such a material we call it transparent. Other materials pass only a fraction of the radiation incident on them and either absorb or reflect the rest (we call such materials translucent or attenuating) and still others absorb or reflect most the radiation incident on them (we call these opaque).

The shorter the wavelength of the radiation is the more energy it carries and the greater is the chance of its passing through various materials without being absorbed or reflected. X-rays have very short wavelengths. They thus carry considerable more energy and are able to pass through many materials without a large fraction of them being absorbed. In fact, the fraction of incident x-rays that is absorbed by a given material depends mostly on the material's density. Thus, dense materials such as lead and gold absorb a much greater fraction of incident x-rays, at a given thickness of the material, than do "light" materials, such as water. Similarly, x-rays, pass mostly unabsorbed through most biological tissues such as muscle and various organs, but they are more strongly absorbed by bone, which has a higher density. X-ray imaging takes advantage of this difference in the x-ray attenuating properties of various tissues in the body.

What we finally see as a finished radiograph is the result of variations in the intensity of the x-ray beam due to differences in attenuation by different tissues. After passing through the body, the x-rays, which have passed through without being attenuated, impinge on fluorescent screens between which a photographic film is sandwiched. The fluorescent screens are made of a dense material designed to absorb most of the incident beam and, on absorbing the x-rays, emitting visible light to which the photographic film is sensitive. They thus expose the film, which is then developed to display the radiograph.

How X-rays Are Made

An x-ray tube is a special case of electronic vacuum tube. It always has a glass envelope with several electrical leads sealed into it, enclosing several electronic elements, with the air removed from it as completely as possible. A schematic diagram of a tube head, which includes the tube itself (glass envelope + contents), is shown as Figure II-1; a typical control panel is shown as Figure II-2.

This section describes how x-rays are generated. Though somewhat oversimplified, the concept is accurate. These steps always occur, though in some modern equipment some of them may happen in a rapid and automatic sequence.

1. The x-ray machine's main power switch is turned ON and the "X-ray Ready" light comes ON. Ordinarily, this is done at the beginning of the workday.

2. The current is adjusted to the value called for by the technique chart, using the current (mA) adjustment control knob. This current heats the filament of the negatively charged cathode, which begins to give off electrons when it gets hot enough. Once the filament gets hot enough to begin emitting electrons (its threshold temperature), it emits them more rapidly, the hotter it gets. A higher current produces a hotter filament which in turn produces a higher rate of electron emission.

   At this stage, the electrons have nowhere in particular to go. Generally, they fly a short distance out into the vacuum, stay there awhile, and finally fall back into the surface of the cathode. This makes a sort of "cloud" of free electrons around the hot cathode, just waiting for something to happen.

3. The high-voltage supply is adjusted to the value prescribed by the technique chart (or by the Licensed Practitioner, in case of special radiography), using the kVp control knob. A typical value is 70,000 peak volts (70 kVp), nearly 1000 times the voltage of ordinary "house" voltage. (This voltage is lethally high; the leads are totally enclosed to protect anyone from touching them.

4. When the operator positions the patient (the object) for the radiograph, he sets the time knob to the appropriate time interval.

5. At this point, the x-ray machine is ready to be used. The electron cloud around the cathode is stabilized according to the mA setting; the high voltage has been set to the desired kVp setting; the time interval is set. **NO X-RAYS ARE GENERATED YET.**

6. When the operator (having taken a safe position behind a protection barrier or 12 feet from the x-ray tube presses the Remote Activator switch (Deadman Switch/ exposure button), (a) the high voltage is imposed between cathode and anode, (b) the automatic timer starts, and (c) the "X-ray ON" light comes ON.

The anode, now bearing a strong positive charge, attracts the free electrons in the cloud around the cathode. The electrons fly through the vacuum to strike (and stick to) the anode, striking the target with so much energy that it emits x-rays and gets quite hot. The higher the kVp, the faster the electrons move to the anode, the harder they strike the target, and the more energetic the x-rays are--that is, the more penetrating capability they have.

The rate at which the cathode emits electrons is a time function. It controls the rate at which x-rays are generated (x-rays per second) at the target--that is, the intensity of the x-ray beam.

The quantity of x-rays, or radiation exposure, is a function of mA x time interval. (This is often referred to in terms of milliampere-seconds (mAs) per radiograph, and relates proportionately to roentgens or to rem in human tissue.) Penetration is a sole function of kVp. The higher the kVp, the harder the beam, the more penetrating the x-rays.

When the exposure time interval (usually less than a second) has expired, a switch automatically opens to remove the high voltage from the tube electrodes. This instantly stops x-ray generation. (If the automatic timer switch malfunctions, the operator's manual Deadman Switch stops x-ray generation immediately when the operator releases finger pressure on the switch. This protects both patient and operator from overexposure.) Because the high voltage is removed from the tube electrodes,

a) Electrons stop moving from cathode to anode.
b) X-ray productions stops.
c) The “X-Ray ON” light goes out.

Figure II-1 shows the basic parts of a x-ray tube head, and their relation to each other:

1. Cathode: the negatively charged (-) side of the x-ray tube, which also includes the filament. Electrons are emitted from the cathode.

2. Filament: wire in the cathode, which is heated to produce free electrons.

3. Focusing Device (Cup): a negatively charged deflector that directs (focuses) electrons into a beam directed at the target.

4. Anode: The positively charged (+) side of the x-ray tube. It contains the target.

5. Target: (See Definition) The part of the anode struck by the electron beam. It is usually made of tungsten, a heavy metallic element with a very high melting point to withstand the heat generated by electron bombardment.

A. Lead Shielding: outer layer of lead within the tube head to absorb stray or scattered x-rays not exiting the tube window or port.

B. Vacuum: the interior of the tube. It has had all the air removed, and must remain sealed in order to function.

C. Beam-Limiting Device: also known as a "collimator", used to limit the diameter of the useful beam.

D. Useful X-ray Beam: the part of the x-ray beam that goes where it is aimed, exposing the patient and the film.

E. Glass Envelope: the shell of the x-ray tube, vacuum-tight.

F. Position-Indicating Device: a device used to aim the primary x-ray beam.

Figure II-2 shows controls and meters. The components of this figure perform the following functions:

A. Remote Activator: remote switch that activates the x-ray machine. This is preferably a Deadman Switch, i.e., a switch which is made so that it is activated only by the operator's continuous pressure, also known as the exposure button.

B. kVp Meter: indicates the peak voltage (kilovolts) between cathode and anode.

C. mA Meter: indicates the current (milliamperes) flowing between cathode and anode.

D. X-ray Ready Light: indicates that the machine is warmed up and ready to operate.

E. X-ray ON Light: lights only during the brief period when the x-ray machine operates.

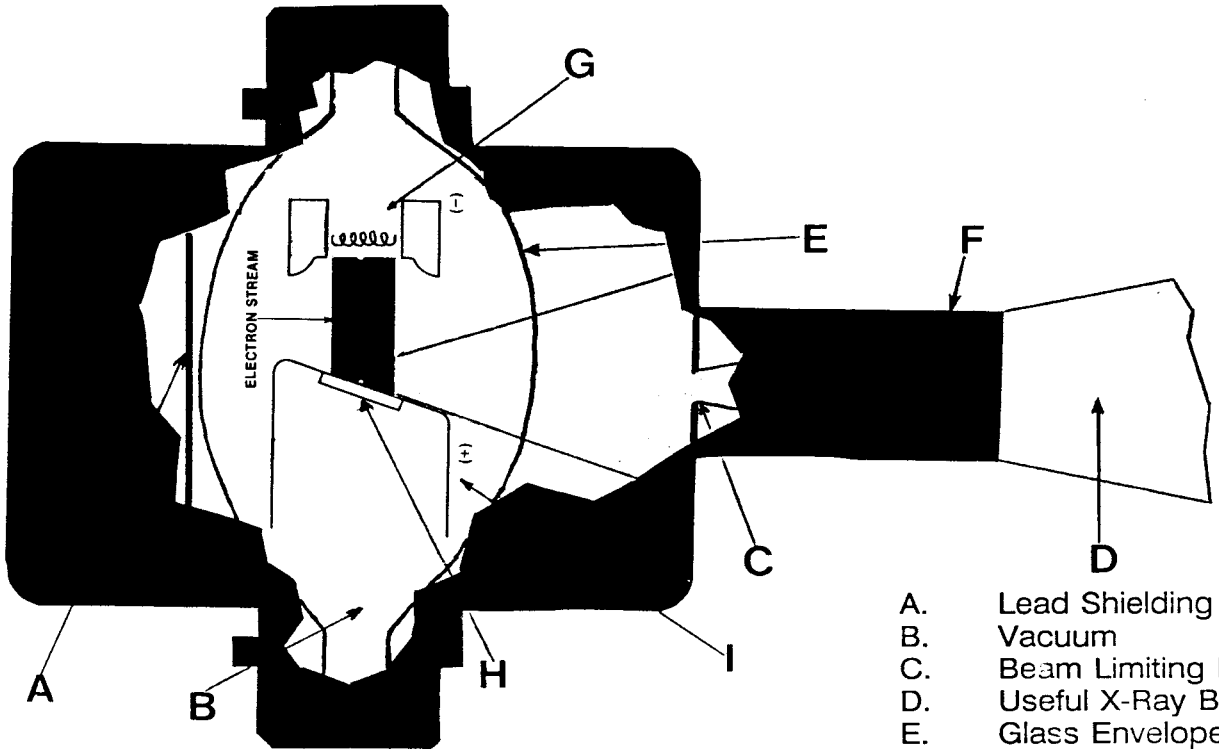
F. Timer: sets the time interval during which the machine generates the x-ray beam. The timer is connected to the TIMER SWITCH. The operator turns the machine ON manually, using the Remote Activator, then the timer switch turns OFF automatically after the preset time interval has elapsed.

G. mA Adjustment Knob: allows you to alter the tube current (mA), by controlling the input. The procedures for individual x-ray machines prescribe the normal range of current values.

H. kVp Adjustment Knob: allows the operator to select the (operating) voltage across the x-ray tube needed to penetrate the part being x-rayed.

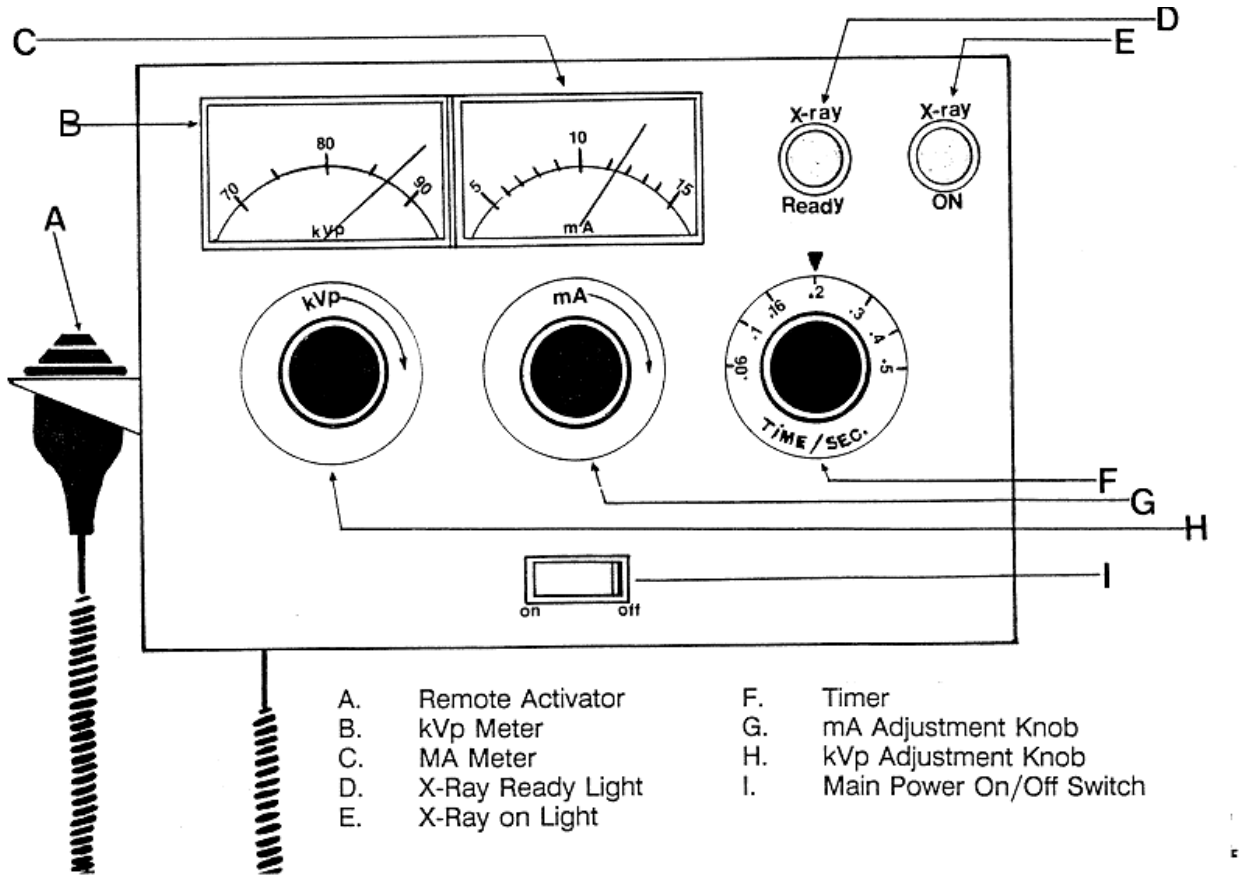
I. Main Power ON/OFF Switch: connects/disconnects electrical power to the x-ray machine.

FIGURE 11-1



A. Lead Shielding
B. Vacuum
C. Beam Limiting Device
D. Useful X-Ray Beam
E. Glass Envelope
F. Position-Indivating Device
G. Cathode
H. Target
I. Anode

FIGURE 11-2



A. Remote Activator
B. kVp Meter
C. MA Meter
D. X-Ray Ready Light
E. X-Ray on Light
F. Timer
G. mA Adjustment Knob
H. kVp Adjustment Knob
I. Main Power On/Off Switch